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ABSTRACT

After surveying the history and current status of online database searching, this report offers a timeline describing four stages of possible developments for online systems. In the first stage, an expert interface assists CD-ROM-based searching by offering advice about search strategies. Advantages are that search logic can be refined with the help of an expert consultant; however, keyboard input is still required. The next stage features online searching conducted through either keyboard or voice input. A problem is that verbal speech has its own limitations--e.g., pronunciation differences and accents. At the next stage, more sophisticated interactive robotics permit database construction and searches through private conversations between user and system. Its diagnostics make the system capable of learning and improving, and able to adapt to personality requirements of an individual user. However, browsing would be almost impossible and robotics are expensive. The final stage depicts a time when neurotransmission of requests from a searcher's mind directly into the system will make it possible for the computer to respond to thoughts rather than words. A problem with this stage includes the necessity of users' learning to erect mental shields to screen out thoughts not related to the search. (SD)

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EXPERT SYSTEMS AND THE FUTURE OF INTERACTIVE SEARCHING

by

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EXPERT SYSTEMS AND THE FUTURE OF INTERACTIVE SEARCHING

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Keywords: Expert Systems, The Future, Interactive Search Techniques, Spoken Commands, Neurotransmission; Thought Transmission

Abstract: Some imaginative solutions are offered in response to present problems surrounding the communication interface between users and information systems. The application of expert systems to interactive searching techniques may result in significant strides ahead in this area, in the near future, but with a little creativity and research, even more can be done to ensure that systems don't just do what you tell them to...they do what you want them to. Among these: (1) systems which respond to spoken commands; (2) systems which converse interactively with the user in natural language; and (3) systems which facilitate the transmission of thought to the system, eliminating the need for language entirely as a medium of communication. Advantages and problems with each of these possibilities are discussed and evaluated.

"Some men see things as they are and say 'why?' I dream things that never were and say 'why not?'" -- Robert F. Kennedy

1. BACKGROUND

Online database searching has come a long way since its birth in the 1960s. While technological has advanced appreciably, however, much room for improvement is possible. Despite changes in the speed, power, versatility, and comprehensiveness of interactive online search systems, several annoying limitations persist:

(1) the searcher must precisely specify the topic to be searched
(2) the searcher must employ terminology which can be understood unambiguously by the search system
(3) there is little standardization of command language (or much of anything else) among existing search systems
(4) commands must be accurately typed into the system in order to retrieve the desired results
(5) cost is a limiting factor on browsing
(6) the system will do only what it is told to do, which is not necessarily what is desired

Circumventing or overcoming these limitations would go a long way towards creation of an improved search system. This paper offers some interesting possible futures for online searching, asking "why not?" Application of an inquiring, non-technical, mind to the problem

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system able to learn new things and add them to its store of knowledge. It follows, therefore, that all limitations and hindrances to the ability of an individual to converse with such a system are the enemy of learning, and must, wherever possible, be overcome.

If machines can be taught such tricks, we ask, why can't they figure out what we're asking of them (our true meaning) and fetch the things we want, avoiding false drops, syntax errors, and similar wastes of money and time? The answer comes easily to mind. People are idiosyncratic: they must formulate their thoughts and wishes into words, and others must ponder those words, in an attempt to divine their meaning. Misunderstands can lead to problems of various sorts, ranging from hard feelings, taking offense where none is intended, to costly or calamitous mistakes. Why can't we bypass this impediment to clear interaction with machines? Why can't we just...well...relate to them?

Experimentation with verbal communication between people and computers is progressing rapidly, but ultimately it will offer no panacea for the woes of keyboard entry. A recent story in the New York Times (January 28, 1989) describes a new computer program that recognizes as many as 5,000 spoken words, and can be trained to recognize the pronunciation of a particular speaker, despite variation in accents, speech impediments, etc. This provides further evidence that computers can learn, as has been well established by pioneers in artificial intelligence. They can also question what they don't understand, and quickly learn how to adjust to unusual pronunciation, cadence, rhythms, or sentence structure. It follows, therefore, that they can learn to listen (perhaps better than even the most intuitive humans) and to grasp the meaning of even the most complex ideas.

One day soon, computers, in assisting with database search terms, will be able to hear, understand, interpret, question, analyze, sort, and respond to spoken commands and identified data elements, having the developmental know-how to converse informally, as well. But even this is far from the ultimate in efficient interactive searching. More worlds are out there waiting to be explored. It is, however, in the nature of expert systems that they are never completed. The good ones just keep getting better and better as they are continually refined and augmented.

5. THE SHAPE OF THINGS TO COME: A TIMELINE

5.1 Stage One: "The State of the Art"

Developments

Expert systems can learn and play games, improving their performance as the result of previous experience, and analyzing the moves of expert opponents until they become expert players, themselves. Communication, however, is still by keyboard or touch-screen. The diagnostic function of the system permits the system to improve its performance in response to continued association with an individual, and to ask questions (like any apt pupil) about anything not understood. The

of expert systems and effective communication, the interface between human searcher and machine program, this paper mixes futurist methodologies and the legal limit of imagination. The paper seeks to create an improved interface between the searcher and the database, using not technologies which are emergent or current, but those yet to be created. The operative criterion is desirability, rather than probability, and the hope is that technology, bonded to human creativity, can provide solutions to the vexing questions, challenges and limitations listed above.

2. THE RECENT PAST

Considering where it has come from and where it has been, online searching has made great strides. Consultation of a computerized database just a quarter of a century ago, where it was available and affordable at all, was an elaborate matter of constructing a deck of cards in a proper sequence and feeding them, one at a time, into a machine for reading. Failure of the user to place a specific card in the proper place, or to keypunch a card correctly, resulted in one of two conditions (both of them bad): either (1) the program would bomb, failing to run at all, or (2) the program would run, yielding garbage. In 1969, the Lockheed Corporation built RECON, the first large-scale online bibliographic retrieval system. RECON went public soon thereafter, becoming the system we use today as DIALOG. By 1972, DIALOG offered over 3 million bibliographic records in more than a dozen files to the general public. Most significantly, input was by keyboard, using a standard English character set, which greatly lessened ambiguity, the eternal enemy of effective information searching.

3. THE PRESENT

"Whether deliberately planned or not, a technological triumph can have social impact at three levels. At the first, it enables us to do what we have been doing, but more cheaply, faster, more reliably, or in some sense significantly better. At the second level, the new technology enables us to do what we could never do before. At the third level, the technology changes our lifestyle."-- Manfred Kochen

Today's users have access to an estimated 68 million database records, yet the above set of limitations still, for the most past, applies. A few technological triumphs (e.g., CD-ROM files and uplinks, such as WILSONDISC) have helped with the reduction of costs, but most of the original problems remain. Current publicly-available search systems respond exclusively to keyboard entry, but just suppose that interaction with the system were voice-based, or even thought-based! Science fiction, perhaps? Well, perhaps. But when Jules Verne wrote of his submersible Nautilus (1870), who would have envisioned that the idea would lead to modern nuclear submarines? When Lee De Forest described television as an interesting toy (1926), but one a long way from commercial feasibility, who could have foreseen the ubiquity of today's medium? And when Science Magazine (in 1948) said that science was at least 200 years away from landing people on the moon and bringing them

back safely, most readers nodded their heads sadly in agreement with that conservative prophesy. Today's futurists can readily attest, however, that prediction is an imperfect science, if science it is at all, and unlikely to get much better.

4. ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS

"Expert Systems are, at this point, the most practical applications of artificial intelligence. An expert system is a computer program that contains the collected knowledge of specialists in a given field; when provided with a specific set of circumstances, the expert system can draw on mountains of data to make a medical diagnosis or to trouble-shoot malfunctions in a locomotive."
-- "A Few Bits of Jargon" Wall Street Journal (September 16, 1985): 96C.

Machine learning is a branch of a relatively new discipline known as "knowledge engineering', and knowledge engineers build expert systems, working hand-in-glove with "domain specialists," or human experts, to gather all the expert's knowledge, to codify it into symbolic form (e.g. condition-action rules) and to make it accessible to others through computer programs. Expert systems, programs emulating the decision processes of experts, can play sophisticated games (a computer program can learn the rules of a relatively complicated game like Go or chess, and apply them in contests, learning from its mistakes and steadily improving its game), prescribe medical treatment, or anticipate how the world's economy is likely to react to cataclysmic events such as global drought or the assassination of a key political leader. Thus far, the domain must be severely limited. At the present stage of technology, it would be too much to ask for a machine to be both a world-class chess player and a medical diagnostician.

The development of expert systems ("experts on disk") is highly desirable because an expert system, unlike a human expert, is affordable, available whenever, reasonably immortal, affordable, diagnostic, developmental, and effective. Condition-action rules, the building blocks of expert systems, are applications of generalized logic to specific situations. Under such rules, a program will, when confronted by a situation (e.g., car won't start), rank-order and trouble-shoot all possibilities, ranging from the obvious (did you put the key in the ignition and turn it?) to situations it would normally take an expert to recognize, diagnose, and treat (are the cylinder compression ratios within recommended tolerances?). For most of us, database searching assisted by an expert system intermediary would be equivalent to bringing a world-famous subject specialist along for consultation when you go to the library to do research for a term paper.

The goal of having an expert system is twofold: (1) to have, at your literal beck and call, an expert in the subject field of your choice, who is not only able but willing to share with you all that is currently known about a given subject, and (2) to have an information

system is capable of adjusting its performance to individual needs or limitations, meaning that the same program can play a beginning chess opponent and a grand master simultaneously, each at his/her own level. CD-ROM-based searching with an "expert" interface can offer advice in the offline construction of search statements, in choice of mode (menu-driven or free search mode), and with status option (searching the disk's contents or going online).

Advantages:

Search logic can be refined offline, with the help of an expert consultant; CD-ROM provides enormous cost savings, and minimizes the negative impact of errors.

Problems:

Keyboard input still required; nothing has been done about the problems resultant from having to type one's thoughts into the computer as words.

5.2 Stage Two: "JUST TELL ME WHAT YOU WANT..."

Developments:

Online searching may now be conducted by keyboard or voice input at the terminal. Natural language requests are processed and interpreted by the system, which can respond in a variety of selectable formats. The expert system program will offer advice on term selection or file choice, on request. The system adjusts to the idiosyncratic speech characteristics of the user. The system also can remember and keep track of users, prior searches, interests, limitations, preferences, etc., and automatically performs SDI (selective dissemination of information), matching new documents to stored profiles of users.

Advantages:

Gone are the problems of having to type out one's thoughts and concepts, using words acceptable to the system and complicated and sometimes variant command structures. Gone also are the problems involved in letting abstract written symbols (letters, numbers, words) represent thoughts.

Problems:

Verbal speech has its own limitations, with pronunciation differences and accents complicating matters greatly. Computers can now converse with users in a variety of languages, but different speakers (dialects, usage) may create semantic confusion in the system.

5.3 Stage Three: Let's Talk About It..."

Developments:

More sophisticated interactive robotics now permit database construction and searches through private conversations between user and system, even in the privacy of one's home. Documents and/or information can be obtained on verbal demand. The system may be accessed by telephone, by computer, or in person, and is completely interactive, providing much more than ever before the sensation of chatting with a friend.

Advantages:

Language barriers, accents, idioms, dialects, are overcome. At-home searching of databases is as close as one's telephone, with the family (cable) television used as a readout device. The system's diagnostics make it capable of learning and improving as it goes along, and of adapting to the personality and requirements of an individual user.

Problems:

(1) Robots cost megabucks. The substantial costs of building such capabilities into terminals will widen the already considerable gulf between the "haves" and the "have-nots." Most libraries (or their successor agencies, whatever they may be called) will have access to such advanced systems, but the poorer segments of the population (who, arguably, need the information the most) will be even further disenfranchised than they are today. (2) Browsing, always a problem in online searches (commands like EXPAND and NEIGHBOR leave much to be desired as means of exploring the system capabilities, and the costs of such expeditions can be daunting) will be tricky in voice-interactive systems. If one were to seek thesaurus terms cognate to a given expression, it would be awkward and less than helpful to have the machine read a list of those terms aloud; some form of print, disk, or screen output is therefore both necessary and desirable. (3) Finally, censorship, which has plagued information searchers since words were first incised on stone tablets, may still be a serious problem in voice-operated systems. Browsing is almost impossible, and information with the most appreciable sales potential is vigorously marketed, but what about the rest?

5.4 Stage Four: "A Penny For Your Thoughts"

Developments:

Neurotransmission of requests from the searcher's mind directly into the system makes it possible for the computer to respond to thoughts, rather than to words. This eliminates semantic problems, and eliminates language barriers altogether. To interact with the system, the user places a headset (resembling a late-twentieth-century crash helmet) over his/her head. Tightening of the chinstrap automatically places sensors in contact with the skull, linking the human mind within to the information system through the electronic transmission of thought.

Advantages:

Time lag between conceptualization of an idea and sharing it with others is eliminated (for those authorized to use the system, anyway) and frees the user from the necessity of translating thoughts into words, which are, at best, abstract representations of concepts.

Problems:

Several. (1) The user must concentrate attentively in order to send a thought to the system. Any sort of "noise" (random thoughts, fantasies, emotions, distractions) which tends to flit through the brain at random moments must be ruthlessly suppressed, lest the system become confused by ambiguous or multiple messages, and shut down, or respond to its perception of the user's requirements in unpredictable ways (e.g., suppose the user thinks "forget it!" meaning merely "never mind," and the system interprets this as an "erase" command, causing a dump of the whole file?). A universal command code, similar to DIALOG's "SS" and meaning "do this" would be needed as a search protocol to screen out unintentional noise. (2) The system might literally read the user's mind (isn't that the putative point of the exercise), affording unseen monitors (Orwell's "thought police" come to mind) entree into one's most personal and private thoughts. The user must learn to erect a mental shield or barrier, to screen out thoughts not related to the search, or not to be shared with the information system. This will take practice; some users may, in fact, never master the requisite degree of mind control. (4) Should the system malfunction anywhere along the line (what system doesn't, once in a while?) the results might be serious for the human intelligence connected to it. A defective machine connected to a vulnerable mind could transmit its short circuit or burnout, resulting in short-term, long-term, or permanent disability, or death. Lawsuits would be the least of the system operator's problems, then. (5) An expert system, developing in unpredictable ways as it interacts with human minds, and developing a "personality," could "catch" or acquire those minds' problems, leading to personality disorders, quirks, neurosis, paranoia, or full-blown psychosis, which might be transmissible (as is a 1980's computer virus) from machine to user, or even from user to other users through the interconnected system.

This conceptualization of the evolution of online systems might very well have exceeded the bounds of plausibility (and we haven't even touched on the problem of desirability; we leave that determination to ethicists). Impossible, you say? Don't bet on it. There are enough new things in our environment since the day the user was born to convince even the most jaded and cynical reader that there's no telling what's coming next.

"When a distinguished but elderly statesman says that something is possible, he is almost certainly right; when he states that something is impossible, he is very probably wrong." -- Arthur C. Clarke